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BOREAS TE-8 Aspen Bark Chemistry Data

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BOREAS TE-8 Aspen Bark Chemistry Data

Shannon Spencer, Barret N. Rock

Summary

The BOREAS TE-8 team collected pigment density data from aspen bark and leaves from four sites within the BOREAS SSA from 24-May-1994 to 16-Jun-1994 (IFC-1), 19-Jul-1994 to 08-Aug-1994 (IFC-2), and 30-Aug-1994 to 19-Sep-1994 (IFC-3). One to nine trees from each site were sampled during the three IFCs. Each tree was sampled in five different locations for bark pigment properties: basal stem section, which was any bark sample taken below one-half the tree height; upper stem section, which was any bark sample taken from the main stem above one-half the tree height; bark taken from branches up to 3 years old; a 2-year-old branch segment; and a 1-year-old branch segment. Additionally, a limited number of leaves were collected. Bark samples were removed from the stem of the tree, placed in ziplock bags, and transported to UNH, where they were processed and analyzed by a spectrophotometer.

In each data file, samples are identified by Site, Date, Tree#, and Sample Location (see 1st paragraph above. Pigment density values are normalized to mg/m^2. Density values for the following pigments are provided: Chl a, Chl b, Total Chl (Chl a+b), Carotenoids, Chl a to b ratio, and the Total Chl to carotenoids ratio. The data are stored in ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-08 Aspen Bark Chemistry Data

1.2 Data Set Introduction

These data are pigment densities for aspen bark samples and aspen leaf samples collected from four sites within the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA) during the three Intensive Field Campaigns (IFCs) of 1994. Each tree was divided into five different bark sampling locations: basal stem, upper stem, branch, 2-year-old branches, and 1-year-old branches. Additionally, several leaves were also measured for pigment density for comparison to bark data.

1.3 Objective/Purpose

The purpose of this work was to understand the potential influence of aspen bark photosynthesis on bark spectra and on the carbon budget of boreal aspen stands.

1.4 Summary of Parameters

Each data set contains the sample location, the chlorophyll (chl) A density, chl B density, total chl density, carotenoid density, ratio of chl A/chl B, and the ratio of total chl/carotenoid.

1.5 Discussion

The bark of aspen (Populus tremuloides) is green and photosynthetic. The phenomenon of bark photosynthesis in aspen has been studied extensively; it has been shown that bark photosynthesis can account for between 5-40% of whole tree photosynthesis. BOREAS used remote sensing systems as a primary means for data collection to better understand the ecosystem-atmosphere interactions. Aspen is a dominant forest cover type, especially in the SSA. Therefore, bark spectral properties could significantly affect data collected and analyzed by remote sensing instruments in BOREAS. The photosynthetic pigment content of the bark affects the spectral properties, and the pigments densities were quantified.

This study was undertaken to quantify the pigment and spectral properties of aspen bark samples (spectral data are presented in separate files with a separate documentation file). The results of this study provide an initial understanding of the potential influence of aspen bark photosynthesis on remotely collected data and carbon budget for aspen stands. A more intensive study should be conducted to scale lab-based spectral measurements to airborne and spaceborne platforms. Additionally, direct measurements of bark photosynthesis would be required to determine the significance to the boreal carbon budget.

The quality of the pigment data is believed to be good. Comparisons with data reported by other researchers who have studied aspen bark photosynthesis show similar results. Additionally, leaf pigment samples correspond to measurements taken by other BOREAS researchers, showing that the bark samples should be of good quality.

1.6 Related Data Sets

BOREAS TE-08 Aspen Bark Spectral Reflectance Data
BOREAS TE-09 NSA Leaf Chlorophyll Density
BOREAS TE-10 Leaf Chemistry Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Slava Kharouk, Scientist
Dr. Barret N. Rock, Associate Professor

2.2 Title of Investigation

Aspen Bark Input in Tree-Atmosphere Interactions

2.3 Contact Information

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3. Theory of Measurements

Bark pigment characteristics, primarily chlorophylls a and b, are important molecule complexes in the process of photosynthesis and carbon assimilation. Therefore, in order to better understand the phenomenon of bark photosynthesis and how it relates to the bark spectral properties, pigment extractions were made of bark and leaf samples. These samples were taken at the same time and place as spectral samples (see BOREAS TE-08 Aspen Bark Spectral Reflectance Data).

4. Equipment

4.1 Sensor/Instrument Description

A Beckman DU-7 spectrophotometer was used to make absorbance measurements. Calibrated 1-cm quartz vials were used for measurements within the spectrophotometer.

4.1.1 Collection Environment

Bark and leaf samples were collected from the field. Measurements took place in laboratory conditions.

4.1.2 Source/Platform

None given.

4.1.3 Source/Platform Mission Objectives

None given.

4.1.4 Key Variables

Chl a, chl b, carotenoid densities.

4.1.5 Principles of Operation

Absorption due to light extinction (see Lichtenthaler, 1987; Gregory, 1989).

4.1.6 Sensor/Instrument Measurement Geometry

None given.

4.1.7 Manufacturer of Sensor/Instrument

Beckman Spectrophotometer, Model DU-7
Beckman Coulter, Inc.
4300 N. Harbor Boulevard
P.O. Box 3100
Fullerton, CA 92834-3100
(800) 742-2345
(800) 634-4366 (fax)

4.2 Calibration

4.2.1 Specifications

Absorption is calibrated based on use of a 100% dimethyl sulfoxide (DMSO) blank in a standard 1-cm quartz cuvette.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

A 100% DMSO blank was used for calibration once every 10 measurements.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

Bark samples from different locations within the tree were collected and analyzed to determine chl a, chl b, total chl (chl a+b), and carotenoid concentrations. At the Paddockwood field site, within a day following collection, bark and leaf samples were removed from the tree using a cork borer of known diameter. Bark sections were peeled off the stem or branch wood, placed in ziplock bags with wet napkins, and kept cool until samples could be processed. These samples were then cut into pieces and added to 4 ml DMSO in capped glass vials, a standard procedure described by Lichtenthaler (1987) and Hixcox and Israelstam (1979) for chlorophyll extraction. Samples were allowed to extract in darkened conditions for 48 hours and were then kept frozen until processing could take place at the University of New Hampshire (UNH). Vials were kept frozen during transport to UNH and were measured within 1 week of arrival (except for IFC-1 samples; see Section 6.1).

At UNH, the extracted solutions were refrigerated for 30 minutes prior to measurement. The spectrophotometer was calibrated using 100% DMSO in a quartz cuvette. Four ml of extract were placed in a 1-cm quartz cuvette, and absorption was measured at four different wavelength positions. The sample was returned to the glass vial. The quartz cuvette was rinsed between samples with 80% acetone and the spectrophotometer was recalibrated every 10 samples. Extract solution absorbance was measured with a Beckman DU-7 spectrophotometer at 470.0 nm, 646.8 nm, 663.2 nm, and 750.0 nm (Lichtenthaler, 1987; Spencer, 1996). The results were printed and then entered into a spreadsheet. Absorbance values were used to calculate pigment concentrations using standard extinction equations reported by Lichtenthaler (1987) (see also Spencer, 1996). Absorption at 750.0 nm (value at 750 should be made equal to zero and the difference is applied to the other wavelengths) was used to calibrate other absorbance values (Middleton, personal communication; Spencer, 1996). Pigment concentration values were then normalized to mg/dm^2 using the known amount of extraction used and the original surface area of the sample extracted.

6. Observations

6.1 Data Notes

Samples from IFC-1 were measured shortly after returning from Canada. However, data were erroneous because of a malfunctioning siphon that was initially used to fill and rinse the cuvette with the sample solution. This problem was noted and corrected. IFC-1 samples had been stored at 4 °C and were remeasured in early August 1994 following correction of the problem.

The authors conducted some preliminary research on bark area leaf area ratios that is not reported here. This information can be found in Spencer, 1996.

6.2 Field Notes

Samples were collected at field sites, placed in ziplock bags, and kept cool until processing. Extractions were conducted at the field lab and were then frozen (about 4 °C) until they were measured with the spectrophotometer at UNH.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

Four sites were sampled during the three 1994 IFCs. Not all sites were sampled during each IFC because of destructive sampling logistics. Two BOREAS tower sites were used: Old Aspen (SSA-9OA) and Young Aspen (YA). Additionally, the originally identified BOREAS YA site was sampled during all three IFCs and is identified in these data sets as the Young Aspen-Auxiliary 04 site (YA-AUX04), and a non-BOREAS mixed aspen and white spruce site is identified as YA-AUX07. One to five trees were destructively harvested during each IFC.

The following is sample collection information at the four SSA locations:

- SSA-9OA: One tree was harvested during IFC-2. Branch samples only were collected during IFC-1, and no samples were collected from the SSA-9OA during IFC-3 because of the logistics of destructive sampling.
- YA-AUX04: Three trees were destructively harvested during each of the three IFCs.
- YA: Five trees were harvested during IFC-2 and -3.
- YA-AUX07: This is a non-BOREAS site that exists within the BOREAS SSA and was established in order to harvest a second mature (>60 yr. old tree) aspen stand for TE-08 research. This site was a mixed site of mature aspen overstory and white spruce understory. It was located on the property of Snow Castle Lodge approximately 3 km N of the SSA-YA site (see Spencer, 1996, for more details). One tree was harvested from this site during IFC-3.

The SSA measurement sites and their associated North American Datum of 1983 (NAD83) coordinates are:

- SSA-9OA, site id C3B7T, Lat/Long: 53.62889 N, 106.19779 W, Universal Transverse Mercator (UTM) Zone 13, N: 5,942,899.9 E: 420,790.5.
- YA, site id D0H4T, Lat/Long: 53.65601 N, 105.32314 W, UTM Zone 13, N: 5,945,298.9 E: 478,644.1.
- YA-AUX04, site id D6H4A, Lat/Long: 53.70828 N, 105.31546 W, UTM Zone 13, N: 5,951,112.1 E: 479,177.5.
- YA-AUX07, Located 3 km N of SSA-YA on the property of Snow Castle Lodge, UTM Zone 13. This was a mixed site of mature aspen overstory (>60 yrs) and white spruce understory.

7.1.2 Spatial Coverage Map

Not available here. See Spencer, 1996.

7.1.3 Spatial Resolution

These data are point measurements at the given location.

7.1.4 Projection

None given.

7.1.5 Grid Description

None given.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

These data were collected from 24-May-1994 to 16-Jun-1994 (IFC-1), 19-Jul-1994 to 08-Aug-1994 (IFC-2), and 30-Aug-1994 to 19-Sep-1994 (IFC-3).

7.2.2 Temporal Coverage Map

None given.

7.2.3 Temporal Resolution

Each site was visited once.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

Column Name
SITE_NAME
SUB_SITE
START_COLLECTION_DATE
END_COLLECTION_DATE
DATE_OBS
TREE_ID
SAMPLE_LOCN
CHLOROPHYLL_A_DENSITY
CHLOROPHYLL_B_DENSITY
TOTAL_CHLOROPHYLL_DENSITY
CAROTENOID_DENSITY
CHLOROPHYLL_A_TO_B_RATIO
TOTAL_CHL_TO_CAROTENOID_RATIO
SPECIES
CRTFCN_CODE
REVISION_DATE

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
START_COLLECTION_DATE	The start date of the period when the samples were acquired, in the form DD-MON-YY:HH:MI, where time is in GMT.
END_COLLECTION_DATE	The end date of the period when the samples were acquired, in the form DD-MON-YY:HH:MI, where time is in GMT.
DATE_OBS	The date on which the data were collected.
TREE_ID	Identifier of the mapped tree or plant stem.
SAMPLE_LOCN	Specific location where the sample was measured.
CHLOROPHYLL_A_DENSITY	Chlorophyll A per unit hemi-surface area.
CHLOROPHYLL_B_DENSITY	Chlorophyll B per unit hemi-surface area.
TOTAL_CHLOROPHYLL_DENSITY	Total chlorophyll (chlorophyll A + chlorophyll B) per unit hemi-surface area.
CAROTENOID_DENSITY	Carotenoid per unit hemi-surface area.
CHLOROPHYLL_A_TO_B_RATIO	The ratio of chlorophyll-A to chlorophyll-B.

TOTAL_CHL_TO_CAROTENOID_RATIO	The ratio of total chlorophyll (chlorophyll-A+ chlorophyll-B) to carotenoid density.
SPECIES	Botanical (Latin) name of the species (Genus species).
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
START_COLLECTION_DATE	[none]
END_COLLECTION_DATE	[none]
DATE_OBS	[DD-MON-YY]
TREE_ID	[none]
SAMPLE_LOCN	[none]
CHLOROPHYLL_A_DENSITY	[milligrams][meter^-2]
CHLOROPHYLL_B_DENSITY	[milligrams][meter^-2]
TOTAL_CHLOROPHYLL_DENSITY	[milligrams][meter^-2]
CAROTENOID_DENSITY	[milligrams][meter^-2]
CHLOROPHYLL_A_TO_B_RATIO	[unitless]
TOTAL_CHL_TO_CAROTENOID_RATIO	[unitless]
SPECIES	[none]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	[BORIS Designation]
SUB_SITE	[BORIS Designation]
START_COLLECTION_DATE	[Human Observer]
END_COLLECTION_DATE	[Human Observer]
DATE_OBS	[Human Observer]
TREE_ID	[Human Observer]
SAMPLE_LOCN	[Human Observer]
CHLOROPHYLL_A_DENSITY	[Laboratory Equipment]
CHLOROPHYLL_B_DENSITY	[Laboratory Equipment]
TOTAL_CHLOROPHYLL_DENSITY	[Laboratory Equipment]
CAROTENOID_DENSITY	[Laboratory Equipment]
CHLOROPHYLL_A_TO_B_RATIO	[Laboratory Equipment]
TOTAL_CHL_TO_CAROTENOID_RATIO	[Laboratory Equipment]
SPECIES	[Human Observer]
CRTFCN_CODE	[BORIS Designation]
REVISION_DATE	[BORIS Designation]

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-90A-FLXTR	SSA-ASP-AUX07	None	None	None	None
SUB_SITE	9TE08-BKC01	9TE08-BKC01	None	None	None	None
START_COLLECTION_DATE	24-MAY-94	05-SEP-94	None	None	None	None
END_COLLECTION_DATE	02-JUN-94	08-SEP-94	None	None	None	None
DATE_OBS	03-AUG-94	11-OCT-94	None	None	None	None
TREE_ID	1	5	None	None	None	None
SAMPLE_LOCN	N/A	N/A	None	None	None	None
CHLOROPHYLL_A_DENSITY	26.8	750.6	-999	None	None	None
CHLOROPHYLL_B_DENSITY	8.7	251	-999	None	None	None
TOTAL_CHLOROPHYLL_DENSITY	38.1	981.7	-999	None	None	None
CAROTENOID_DENSITY	7.6	302.1	-999	None	None	None
CHLOROPHYLL_A_TO_B_RATIO	.42	7.56	-999	None	None	None
TOTAL_CHL_TO_CAROTENOID_RATIO	.56	5.07	-999	None	None	None
SPECIES	N/A	N/A	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	18-NOV-98	24-DEC-98	None	None	None	None

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.
Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.
Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A -- Indicates that the value is not applicable to the respective column.

```
None  -- Indicates that no values of that sort were found in the column.
-------------------------------------------------------------------------------
```

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,DATE_OBS,START_COLLECTION_DATE,END_COLLECTION_DATE,TREE_ID,
SAMPLE_LOCN,CHLOROPHYLL_A_DENSITY,CHLOROPHYLL_B_DENSITY,
TOTAL_CHLOROPHYLL_DENSITY,CAROTENOID_DENSITY,CHLOROPHYLL_A_TO_B_RATIO,
TOTAL_CHL_TO_CAROTENOID_RATIO,SPECIES,CRTFCN_CODE,REVISION_DATE
'SSA-90A-FLXTR','9TE08-BKC01',03-AUG-94,24-MAY-94,02-JUN-94,1,'LEAVES',142.0,
37.0,179.0,66.0,3.88,2.7,'Populus tremuloides','CPI',18-NOV-98
'SSA-90A-FLXTR','9TE08-BKC01',03-AUG-94,24-MAY-94,02-JUN-94,1,'LEAVES',117.0,
33.0,150.0,54.0,3.57,2.77,'Populus tremuloides','CPI',18-NOV-98
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was the data collected at a given site on a given date.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

Absorption data were calibrated with absorption data from the 750-nm band and were then input into the extinction equations listed in Section 9.1. These values were then normalized for the amount of solution used and the surface area of the sample to arrive at a figure in mg/dm^2. See Section 9.2.1 for further details.

Extinction coefficients are from Lichtenthaler (1987):

$$[\text{chl a}] = 12.25A(663.2) - 2.79A(646.8) \quad (1)$$

$$[\text{chl b}] = 21.50A(646.8) - 5.10A(663.2) \quad (2)$$

$$[\text{chl a+b}] = [\text{chl a}] + [\text{chl b}] \quad (3)$$

$$[\text{carotenoids}] = (1000A(470) - 1.82[\text{chl a}] - 85.02[\text{chl b}])/198 \quad (4)$$

where A(wavelength) is the absorption at the specified wavelength.

9.1.1 Derivation Techniques and Algorithms

Not applicable.

9.2 Data Processing Sequence

9.2.1 Processing Steps

- Absorption results were entered into a spreadsheet.
- Absorption at 750.0 nm (value at 750 was made equal to zero and the difference was applied to the other wavelengths) was used to calibrate other absorbance values (Middleton, personal communication; Spencer, 1996).
- Pigment concentration values were then normalized to mg/dm^2 using the known amount of extraction used and the original surface area of the sample extracted.
- Absorbance values were used to calculate pigment concentrations using standard extinction equations reported by Lichtenthaler (1987) (see also Spencer, 1996).
- As part of its data integration efforts, BORIS staff converted the pigment concentration values to mg/m^2 to be compatible with other similar measurements.

9.2.2 Processing Changes

None given.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Data were corrected with the measurement at 750 nm because of the purity of the DMSO and the possibility for debris in the extract solution. The value at 750 nm should be equal to zero for chlorophyll and pigment absorption. If the absorption value at 750 nm was greater than 0.01, the sample was rerun or discarded.

9.3.2 Calculated Variables

See Sections 9.1 and 9.3.1.

9.4 Graphs and Plots

None given.

10. Errors

10.1 Sources of Error

Error could have been created by the calibration discussed in Section 9.3.1. The extraction solution should have been filtered to avoid this problem. However, discussions with other BOREAS teams measuring chlorophyll concentration showed TE-08's calibration method discussed in Section 9.3.1 to be an acceptable practice.

10.2 Quality Assessment

Several tests were conducted to be sure that consistent, reliable data were collected by the instrument. The tests included comparisons of light absorption to a standard of 100% DMSO and comparisons of results with those of TE-10. Our data appear to be consistent with TE-10's results.

10.2.1 Data Validation by Source

None given.

10.2.2 Confidence Level/Accuracy Judgment

The data appear to be good. Leaf chlorophyll data were checked against those of TE-10 and found to be not significantly different.

10.2.3 Measurement Error for Parameters

None given.

10.2.4 Additional Quality Assessments
All data were checked for potential problems and discarded if problems were evident.

10.2.5 Data Verification by Data Center
Data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
These data are calculated on an area basis rather than a weight basis because of the bark tissue heterogeneity.

11.2 Known Problems with the Data
None given.

11.3 Usage Guidance
None given.

11.4 Other Relevant Information
None given.

12. Application of the Data Set

These data provide information on the chlorophyll density of aspen bark. This information can be scaled up to the whole tree level to determine the amount of whole tree chlorophyll found in the bark tissue. This gives a preliminary indication as to the importance of bark photosynthesis on a whole tree/stand level. More work should be done in this area to determine bark photosynthesis significance to aspen carbon dynamics. Gas exchange measurements should be conducted on aspen bark during different times of the year. See Spencer, 1996, for more discussion.

13. Future Modifications and Plans

These data have been presented in more detail in Spencer, 1996.

14. Software

14.1 Software Description
Quattro Pro 4.0 was used for most analyses and then Excel 5.0 was used for the final and summative analyses. For a statistical package TE-08 used Stata Pro 4.0.

14.2 Software Access
None given.

15. Data Access

The aspen bark chemistry data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

Beckman Spectrophotometer Manual, Beckman Spectrophotometer, Model DU-7, Beckman Coulter, Inc., Fullerton, CA 92834-3100.

17.2 Journal Articles and Study Reports

Gregory, R.P. 1989. Photosynthesis. Chapman and Hall. NY, NY. 160 pp.

Hixcox, J.D. and G.F. Israelstam. 1979. A method for the extraction of chlorophyll from leaf tissue without maceration. Can. J. Bot. 57:1332-1334.

Lichtenthaler, H.K. 1987. Chlorophylla and carotenoids: pigments of photosynthetic biomembranes. Methods in Enzymology. 148:349-382.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Rock, B.N. et al. 1994. High-spectral resolution field and laboratory optical reflectance measurements of red spruce and eastern hemlock needles and branches. Remote Sensing of Environment. 47:176-189.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

Spencer, S.L. 1996. Anatomical, Pigment, and Spectral Evidence of Cortical Photosynthesis in Populus tremuloides from the Canadian Boreal Region. Master's Thesis, Dept. Nat. Res., University of New Hampshire, 186 pp.

Spencer, S.L. and B.N. Rock. 1996. Assessing aspen bark carbon assimilation in the boreal region. In Proceedings of 22nd Conference on Agricultural and Forest Meteorology with Symposium on Fire and Forest Meteorology. 28 January-2 February, 1996, Atlanta, Georgia. American Meteorological Society, pp:86-89.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only Memory
CHL	- Chlorophyll
DAAC	- Distributed Active Archive Center
DMSO	- Dimethyl Sulfoxide
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
FOV	- Field-of-View
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NOAA	- National Oceanic and Atmospheric Administration
NSA	- Northern Study Area
OA	- Old Aspen
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
SSA	- Southern Study Area
TE	- Terrestrial Ecology
UNH	- University of New Hampshire
URL	- Uniform Resource Locator
UTM	- Universal Transverse Mercator
YA	- Young Aspen
YA-AUX	- Young Aspen-Auxiliary

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS TE-8 team collected pigment density data from aspen bark and leaves from four sites within the BOREAS SSA from 24-May-1994 to 16-Jun-1994 (IFC-1), 19-Jul-1994 to 08-Aug-1994 (IFC-2), and 30-Aug-1994 to 19-Sep-1994 (IFC-3). One to nine trees from each site were sampled during the three IFCs. Each tree was sampled in five different locations for bark pigment properties: basal stem section, which was any bark sample taken below one-half the tree height; upper stem section, which was any bark sample taken from the main stem above one-half the tree height; bark taken from branches up to 3 years old; a 2-year-old branch segment; and a 1-year-old branch segment. Additionally, a limited number of leaves were collected. Bark samples were removed from the stem of the tree, placed in ziplock bags, and transported to UNH, where they were processed and analyzed by a spectrophotometer. In each data file, samples are identified by Site, Date, Tree#, and Sample Location (see 1st paragraph above. Pigment density values are normalized to mg/m^2. Density values for the following pigments are provided: Chl a, Chl b, Total Chl (Chl a+b), Carotenoids, Chl a to b ratio, and the Total Chl to carotenoids ratio. The data are stored in ASCII files.

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